Preparation and electrochemical properties of tin(IV) oxide – graphene oxide film electrodes

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Graphene oxide (GO) is an object of great interest for materials science, due to its use for preparation of membranes of exceptional filtering capacity and strength [1], graphene production via GO by various techniques based on Hummers method [2], etc. Graphene oxide has attracted also much attention recently [3, 4], as electrode material which combines recognized advantages of graphene with additional possibilities for electoactive interfaces design that result from oxygen-containing functional groups in GO molecular structure. In electrochemical applications, the use of a binding component could provide additional benefits. In order to bring about the advantages of the two-component electrode materials, we have developed a method of preparation of tin(IV) oxide – graphene oxide film electrodes and tested the electrodes in the reaction of anodic oxidation of chloride anions and also in lithium cathodic intercalation.

Graphene oxide was prepared from graphite via a modified Hummers [2] method, using the preoxidation stage that was based on optimization of Kovtyukhova et al. [5] procedure. Graphite powder was first preoxidized in a mixture of phosphorous(V) oxide, sodium persulfate and sulfuric acid and further oxidized to graphite oxide in a mixture with potassium nitrate, potassium permanganate and sulfuric acid. Thus obtained graphite oxide was exfoliated by sonic treatment, and the graphene oxide sol was finally separated from graphite oxide residue by centrifugation and identified by Raman spectroscopy. Graphene oxide sol was mixed with SnO_2 sol in different proportions to obtain composite tin(IV) oxide – graphene oxide film electrodes of various composition by dip coating the conducting ITO (mixed indium and tin oxide) glass.

The surface area of the composite electrodes monitored by double layer capacitance showed a strong increase with GO content up to 40 % GO. It was diminishing with the further increase in GO content. The composite electrodes were characterized by high electrocatalytic activity in anodic oxidation of Cl^- anions in concentrated aqueous solutions of alkali metal chlorides, in contrast with the unmodified SnO_2-electrode. The anodic reaction manifested strong effect of alkali metal cation, which was explained by the effect of different ion pairing in chloride solutions with different cations and the ion pair interaction with adsorbed chloride. We have also found that the cathodic treatment in the potential range of lithium intercalation in LiCl solution in acetonitrile activated the cathodic reduction of graphene oxide in the composite electrodes.

Reference

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